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THE POPULATION DENSITY OF MONSTERS IN OKANAGAN LAKE, BRITISH COLUMBIA*[1]

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ABSTRACT

A quantitative food web of Okanagan Lake, British Columbia, Canada, is presented which shows that the lake could support a small population of large reptilian monsters, lending credence to recurring sightings of a creature called 'Ogopogo.' Using arguments drawn from population genetics, we suggest two alternative population structures for Ogopogo, and a number of phenotypic attributes, notably dimorphism and a pale coloration, which explain certain aspects of the sightings reported so far. Whatever their actual population structure, Ogopogo appear endangered by the present fisheries in Lake Okanagan, which should be immediately closed.

INTRODUCTION

It is well known that there are monsters in Okanagan Lake. Between 1874 and 1991, over 300 very credible people reported a total of 174 sightings (Mangiacopra 1992). The actual number of sightings is probably higher than this, as some may have kept silent for fear of ridicule. Most recent sightings occurred near the bridge between Kelowna and Westbank (Mangiacorpa 1992), which runs over an underwater ridge that separates the lake into two basins (Ashley *et al.* 1999), forcing any large animal crossing from one basin to the other to come closer to the surface, and thus becoming visible.

As for monsters in many other areas (see Sheldon and Kerr 1972), the sightings elicit similar descriptions from viewers: the animal is 15-25 feet long (5 to 8 m) and is 2-5 feet in diameter (about 1/2 to 2 m) with a head sporting features reminiscent of horses, goats and snakes (Gaal 1986; www.strangemag.com/ogopogo.html).

Some critics have suggested that the sporadic nature of Ogopogo sightings and the absence of hard evidence (carcasses, feces, bones, etc.) imply that there are no monsters in Okanagan Lake. But absence of evidence is not evidence of absence. Indeed, as Sheldon and Kerr (1972) have stated in dealing with similar criticisms regarding the existence of the Loch Ness monster, "this is both irresponsible and illogical." This is especially true as Okanagan Lake is quite large (113 km in length and 5.2 km across at its widest point; Clemens *et al.* 1939; Ashley *et al.* 1999), and deep (maximum depth 242 m), thus offering many hiding places.

To advance the overdue scientific and public debate on Ogopogo, this contribution examines the food web of Okanagan Lake in terms of its ability to supply the food resources required by a small population of monsters.

We used for this the widely used Ecopath modeling approach and software (Christensen and Pauly 1992; Pauly and Christensen 1996; Pauly *et al.* 2000; see www.ecopath.org). Herein, the biotic resources within an ecosystem (here: Okanagan Lake) are represented as single species or as groups of functionally similar species, interlinked through their energy requirements. The key feature of the Ecopath approach is that it assumes mass-balance, i.e., the biomass flows out of groups within the system (through predation, feces, or respiration) must equal the flows into these same groups (i.e., their consumption).

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[1] Originally submitted (in 2001) to a journal called *Cryptozoology*, where it was kind of accepted just before the journal foundered, possibly because the *Crypto-* part overwhelmed the *-zoology* part.

The food web presented here represents Okanagan Lake during the year 2000. The carrying capacity of the lake has fallen dramatically since 1970, leading to the decline of its kokanee salmon population to 10% of 1970 abundance levels (Ashley *et al.* 1998). As this would have affected the Ogopogo population, it can be assumed that the lake could have supported their population in previous years if it can be shown that the lake now still has the resources necessary to support an Ogopogo population.

A total of 17 functional groups were included in the food web: Ogopogo; young kokanee (age 0+); adult kokanee (age 1-3); four groups of 'other fish' (juveniles and adults, inshore and deep water), two groups of *Mysis relicta* (juvenile and adults); midge larvae, other insect larvae, copepods, cladocerans, *Daphnia* spp., rotifers, phytoplankton, and detritus. The basic input parameters for all groups are given in Table 1, while their diet composition is given in Table 2. For all groups except Ogopogo, these values in these tables were adapted (in that order) from studies of Lake Okanagan, other lakes in British Columbia, or other aquatic systems (details in Kay 2002).

Table 1. Basic inputs for constructing of food web model of Okanagan lake**.**

Group	P/B (year^{-1})	Q/B (year^{-1})	*P/Q*
Ogopogo	0.080[a]	1.110[g]	-
Adult other Fish (deep water)	-	1.990[d]	0.182[f]
Juvenile other Fish (deep water)	-	4.570	0.300
Kokanee (age 1-3)	0.710[b]	3.700[d]	-
Kokanee (age 0+)	-	8.500[h]	0.300[j]
Mysis relicta (adult)	2.659[c]	18.250[i]	-
Mysis relicta (juvenile)	-	25.000	0.221[k]
Adult other Fish (near shore)	0.646[d]	3.304[d]	
Juvenile other Fish (near shore)	-	7.590	0.300
Midge larvae	-	30.000	0.143
Aquatic insect larvae	-	30.000	0.143
Copepods	18.250[e]	-	0.143
Cladocerans	47.500[e]	-	0.143
Daphnia	47.500[e]	-	0.143[f]
Rotifers	50.000	-	0.099[f]
Phytoplankton	150.000[f]	-	-

a) Webb *et al*, 1987; b) Sandercock (1969); c) Stockwell and Johannsson (1997); d) Froese and Pauly (2000); e) Langeland (1982); f) Thompson (1999), including EE estimate of 0.757 for rotifers; g) Auffenberg (1981); h) Foerster (1968); I) Langeland *et al.*, (1991); j) Johnston *et al.* (1988); k) Chess and Stanford (1999).

The parameters for Ogopogo were adapted from consumption/biomass ratio for Komodo dragon, *Varanus komodoensis* (Auffenberg 1981), and production/biomass ratio for large Australian sea-going crocodiles, *Crocodylus porosus* (Webb *et al.* 1987), scaled down to an average temperature of 10 degrees Celsius, and up to an mean body weight of 1,000 kg.

Sheldon and Kerr (1972) evaluated the requirements for a monster population to persist over time, and suggested a population consisting of no fewer than 10 animals, each with a minimum adult weight of 100 kg. The food web we constructed shows that Okanagan Lake could support a population of Ogopogo with a total biomass not exceeding 50 t, i.e., about 5 t per animal given a population of 10 animals. This is very close to the mean weight of 5160 kg that can be estimated from the average body length and diameter reported for Ogopogo by Mangiacopra (1992). Thus, we find an amazing match between the mean body weight predicted from the food web analysis and the estimate based on actual sightings.

However, a more recent underwater sighting of Ogopogo suggests another possibility. On August 24th, 2000, Mr. Darryl Ellis was swimming in Okanagan Lake when he noticed two Ogopogo swimming directly underneath him (www.sunnyokanagan.com/ogopogo). He described one of the animals to be 20 feet long, with a long slender body, as reported by earlier observers, while the other, described as "fat" and of a "boxy shape," was thought to be only 100-200 kg. An obvious interpretation is that the smaller animal was a pup.

An alternative, and we believe, more likely, explanation is that most Ogopogo are relatively small, and hence usually overlooked. Large Ogopogo, then would be exceptional (i.e., rare), but over-represented in sightings, due to their size.

Small, isolated populations, whose members are forced to interbreed, are susceptible to a number of hereditary diseases. One such disease, Homocystinuria, is an autosomal recessive condition that results in abnormally tall and slender offspring (Brenton *et al.* 1972; Boers 1986; Gilbert 1996), an effect called 'giganticism.' Two giant

Ogopogo (of 5 t each) would allow the lake's food web to also sustain approximately 200 smaller (200 kg) Ogopogo.

Another effect of Homocystinuria is short-sightedness, perhaps the reason why large Ogopogo are only sporadically seen lifting their head above the water surface. Being short-sighted, they have no reason to lift their heads more than required for surface respiration. While many hereditary diseases result in some form of arrested mental development, Homocystinuria sufferers have normal mental capabilities (Gilbert 1996), and hence we can expect large Ogopogo to remain circumspect, as other wildlife do.

Table 2. Diet composition for food web model of Okanagan Lake in the year 2000 (all entries in ‰; based on sources documented in Kay (2002); d.w. = deep water; n.s. = near shore.

Predator\Prey	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1 Ogopogo														
2 Ad. other fish (d. w.)	0.014													
3 Juv. other fish (d. w.)	0.001													
4 Kokanee (1-3)	0.685	0.422												
5 Kokanee (0+)	0.050	0.168						0.009						
6 *M. relicta* (adult)	0.250													
7 *M. relicta* (juv)														
8 Adult other fish (n.s.)		0.035												
9 Juv. other fish (n. s.)								0.025						
10 Midge larvae			0.460					0.323	0.387					
11 Aquatic insect larvae			0.357					0.290	0.357	0.200				
12 Copepods		0.020	0.005	0.125	0.211	0.100	0.071	0.108	0.075		0.050	0.050		
13 Cladocerans		0.057	0.011	0.031	0.026	0.025	0.018	0.168	0.100			0.025	0.025	
14 *Daphnia*		0.228	0.041	0.844	0.763	0.555	0.034					0.050	0.025	
15 Rotifers						0.095	0.068					0.050	0.025	
Phytoplankton		0.070	0.126				0.286	0.077	0.081	0.500	0.150	0.825	0.925	1.000
Detritus						0.225	0.254			0.300	0.800			

The greatest worry for Homocytinuria sufferers is their propensity for thromboses. However, diets that are high in vitamin B6 appear to limit this aspect of the disease (Gilbert 1996). Fish are known to contain high levels of vitamin B6 compared to other meats and salmon, in particular, contain very high levels of this vitamin (Ensminger *et al.* 1983; Leveille *et al.* 1983); hence Ogopogo would be protected, as they consume fish (Table 2).

Another condition frequent in small vertebrate populations is albinism, i.e., complete or extensive lack of pigmentation. The latter has been reported from the large sea-going crocodiles, *Crocodylus porosus* (Kar and Bustard 1982). A similar condition also affects the Great Spirit or Kermode Bear, inhabiting the coastal rainforests of British Columbia, which have pigment only in their iris and on their nose. Partial albinism, occurring both in reptilians related to Ogopogo, and in British Columbian predators, provides another explanation why Ogopogos are not seen as frequently as their number warrant: it is likely that they surface in the morning, when a fog covers both Okanagan Lake, and the white bodies of the monsters.

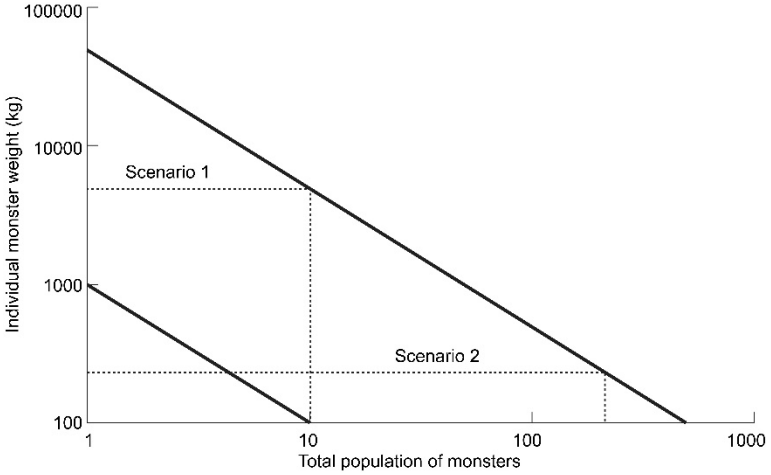

Figure 1: Probable number of monsters in Okanagan Lake, British Columbia. Upper solid black line: maximum sustainable standing stock; lower solid black line: minimum viable population.

Figure 1 shows the two population scenarios described earlier. Scenario 1 is a lake that

contains 10 large Ogopogos, each weighing approximately 5 t. Scenario 2 is a lake with about 200 smaller, 200 kg Ogopogo, with one or two larger Ogopogo (5 t each) appearing as genetic oddities. The upper and lower lines in Figure 1 thus represent the maximum possible population, as calculated from the food web analysis and the constraints of Sheldon and Kerr (1972) for Loch Ness monsters. Scenario 1 allows all Ogopogo to match the mean weight estimated from the sightings in Mangiacopra (1992). The problem is that 10 large Ogopogo would lead to more sightings than are recorded. Also, this scenario does not account for the recent sighting of a small Ogopogo, unless one assumes it was a pup. Scenario 2 offers the possibility of a few large Ogopogo that do not surface often and smaller Ogopogo that remain less conspicuous. Even if the smaller Ogopogo are sighted, they are more likely to be misidentified as logs or other objects, and remain unreported.

We cannot tell which of the two scenarios is most likely, given present knowledge on their population dynamics. The important point is that one can make a scientific case that Okanagan Lake can support the Ogopogo living therein. Therefore, measures to ensure their protection must be taken immediately. While the shooting of Ogopogo is currently considered illegal under section 26 of the Fisheries Act (Gaal 1986), it would not be illegal to cause the death of Ogopogo through other means. Effective immediately, Ogopogo should be listed under the Endangered Species Act, and all fishing on Okanagan Lake should be stopped. It is realized that the fishery for kokanee salmon is already closed, but this should be expanded to halt the budding *Mysis relicta* fishery and all other fisheries as well. In the absence of such strict measures, depletion of the remaining food sources for Ogopogo could cause a food web collapse that would lead to their extinction.

We hope that this contribution, will lead not only to the protection of Ogopogo, but also to the protection of monsters in other North American lakes. However, we are well aware that the sterile debates about their very existence will continue, and, in many cases, even preclude the implementation of effective measures for their protection.

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